Integrated Status and Effectiveness Monitoring Program- Entiat River Smolt Monitoring Program, Snorkel Surveys, and Steelhead Redd Surveys, 2009.

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Abstract

The Mid-Columbia Fishery Resource Office (MCRFRO) operated two rotary screw traps, conducted effectiveness monitoring snorkel surveys, and performed steelhead redd surveys on the Entiat River during 2009 as part of the Integrated Status and Effectiveness Monitoring Program (ISEMP). Screw trap operations were conducted between February and November. Along with the screw traps, juvenile emigrants were also collected in remote locations throughout the Entiat River watershed, including its major tributary, the Mad River. The screw traps caught a total of 38,351 fish, while 2,760 were collected via remote capture. Salmonids accounted for 82% of the fish caught in the traps. A total of 12,082 wild salmonids were PIT tagged between these two capture methods. Trap efficiencies for the upper trap averaged 28.21% for spring Chinook salmon and 11.76% for rainbow trout/steelhead. Lower trap efficiencies averaged 16.37% for spring Chinook salmon and 13.82% for rainbow trout/steelhead. Snorkel surveys were conducted at 30 sites during the winter and summer periods. A total of 50,282 fish from 15 species/genera and an unknown category were observed during the snorkels. Rainbow trout/steelhead were the most abundant during the winter snorkel (65%), while mountain whitefish were the most observed during the summer period (22%). Steelhead redd surveys took place between February 13 and June 25, 2009. The first redd was observed on March 25, and no new redds were seen after May 13. A total of 200 redds were observed in the lower 45 kilometers of the river. The majority (64%) were below the Entiat National Fish Hatchery (rkm 10.6). There were 41 redds (20.5%) in restoration areas or irrigation diversions.

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Introduction

The Integrated Status and Effectiveness Monitoring Program (ISEMP – BPA project #2003-0017) has been created as a cost effective means of developing protocols and new technologies, novel indicators, sample designs, analytical, data management and communication tools and skills, and restoration experiments that support the development of a region-wide Research, Monitoring and Evaluation (RME) program to assess the status of anadromous salmonid populations, their tributary habitat and restoration and management actions.

The most straightforward approach to developing a regional-scale monitoring and evaluation program would be to increase standardization among status and trend monitoring programs. However, the diversity of species and their habitat, as well as the overwhelming uncertainty surrounding indicators, metrics, and data interpretation methods, requires the testing of multiple approaches. Thus, the approach ISEMP has adopted is to develop a broad template that may differ in the details among subbasins, but one that will ultimately lead to the formation of a unified RME process for the management of anadromous salmonid populations and habitat across the Columbia River Basin.

ISEMP has been initiated in three pilot subbasins, the Wenatchee/Entiat, John Day, and Salmon. To balance replicating experimental approaches with the goal of developing monitoring and evaluation tools that apply as broadly as possible across the Pacific Northwest, these subbasins were chosen as representative of a wide range of potential challenges and conditions, e.g., differing fish species composition and life histories, ecoregions, institutional settings, and existing data.

ISEMP has constructed a framework that builds on current status and trend monitoring infrastructures in these pilot subbasins, but challenges current programs by testing alternative monitoring approaches. In addition, the ISEMP is:

1) Collecting information over a hierarchy of spatial scales, allowing for a greater flexibility of data aggregation for multi-scale recovery planning assessments, and

2) Designing methods that:

a) Identify factors limiting fish production in watersheds;

b) Determine restoration actions to address these problems;

c) Implement actions as a large-scale experiment (e.g. Before After Control Impact, or BACI design), and

d) Implement intensive monitoring and research to evaluate the action's success.

The intent of the ISEMP project is to design monitoring programs that can efficiently collect information to address multiple management objectives over a broad range of scales. This includes:

- Evaluating the status of anadromous salmonids and their habitat;
- Identifying opportunities to restore habitat function and fish performance, and

• Evaluating the benefits of the actions to the fish populations across the Columbia River Basin.

The multi-scale nature of this goal requires the standardization of protocols and sampling designs that are statistically valid and powerful, properties that are currently inconsistent across the multiple monitoring programs in the region. Other aspects of the program will aid in the ability to extrapolate information beyond the study area, such as research to elucidate causal mechanisms, and a classification of watersheds throughout the Columbia River Basin. Obviously, the scale of the problem is immense and the ISEMP does not claim to be the only program working towards this goal. As such, ISEMP relies heavily on the basin's current monitoring infrastructure to test and develop monitoring strategies, while acting as a coordinating body and providing support for key elements such as data management and technical analyses. The ISEMP also ensures that monitoring programs can address large-scale management objectives (resulting largely from the ESA) through these local efforts. While the ISEMP maintains a regional focus it also returns the necessary information to aid in management at the smaller spatial scales (individual projects) where manipulations (e.g., habitat restoration actions) actually occur.

The work captured in this report is a component of the overall ISEMP, and while it stands alone as an important contribution to the management of anadromous salmonids and their habitat, it also plays a key role within ISEMP. Each component of work within ISEMP is reported on individually, as is done so here, and in annual summary reports that present all of the overall project components in their programmatic context and shows how the data and tools developed can be applied to the development of regionally consistent, efficient and effective Research, Monitoring and Evaluation.

Juvenile outmigration study

The primary goal of this study is to provide long-term monitoring information about the juvenile life history characteristics and productivity of ESA listed spring Chinook salmon and steelhead in the Entiat River basin. Specifically, the study primarily utilizes migrant traps and to some extent seines and angling to capture juveniles in order to quantify abundance, measure physical characteristics, and tag individuals to assess migration timing and survival. Once obtained this data is incorporated into a regional database that is utilized by area resource managers to compare attributes both within and among populations located in the Upper Columbia River basin. The final outcome of this study is to guide scientifically sound decisions regarding the future management of these imperiled species.

This document reports the data collected from juvenile collection operations from January 1 2009 through November 16th 2009.

Snorkel surveys

In 2005, the Cascadia Conservation District (CCD) in association with the Entiat Watershed Planning Unit (EWPU) initiated a large-scale restoration program in a 2,000 m section of the Entiat River watershed, known as the "Entiat Bridge-to-Bridge Project". This was a phased program that proposed to over a several year period incorporate a suite of stream restoration measures that include in-stream habitat structures, reconnection of

relict stream channels, and riparian plantings. The habitat restoration efforts in the Entiat River are intended to provide complexity to the river system and a positive benefit for aquatic organisms including ESA listed fish species. This project has since grown to include the entire Entiat River watershed, and is now included in the watershed scale project know as the Intensively Monitored Watershed (IMW).

The U.S. Fish and Wildlife Service's Mid-Columbia River Fishery Resource Office (MCRFRO) has conducted the snorkeling component of the Entiat Effectiveness Monitoring Study that will evaluate fish habitat utilization associated with in-stream restoration work as it applies to the development of the IMW.

The objective of this study during 2009 was to conduct pre-project monitoring for the IMW by surveying the fish habitat utilization of in-stream restoration efforts in the Entiat River.

Steelhead redd surveys
The primary goal of this study is to enumerate steelhead redds and describe distribution of those redds in the main Entiat River.

Study Area

The Entiat River watershed originates from 11 glaciers and snowfields in the Cascade Mountains and flows southeast approximately 69 km to join the Columbia River at river kilometer (rkm) 778 (CCCD 2004, Mullan et al. 1992). The Entiat watershed is bordered by the Entiat Mountains to the southwest and the Chelan Mountains to the northeast and drains approximately 1,085 km^2. The topography is steep with unstable erodible soils and vegetation types varying from semi-arid shrub steppe near the confluence with the Columbia River to temperate forests and alpine meadows in the headwaters.

Past glacial activity has shaped the Entiat River valley by creating a U-shaped valley upstream of terminal moraine at rkm 26.1 and V shaped valley downstream (Mullan et al. 1992). The present upstream limit to anadromy is at Entiat Falls (rkm 54.4) (Figure 1).

The Entiat River watershed supports seven native and one introduced salmonid species which include, spring and summer Chinook salmon *Oncorhynchus tshawytscha*, steelhead and resident rainbow trout *O. mykiss gairdneri,* sockeye salmon *O. nerka*, westslope cutthroat trout *O. clarki lewisi,* coho salmon *O. kisutch*, mountain whitefish *Prosopium williamsoni,* bull trout *Salvelinus confluentus,* and introduced eastern brook trout *S. fontinalis*. Other fish species include, chiselmouth *Acrocheilus alutaceus*, northern pikeminnow *Ptychocheilus oregonensis*, largescale sucker *Catostomus macrocheilus*, bridgelip sucker *C. columbianus*, speckled dace *Rhinichthys osculus*, longnose dace *R. cataractae*, redside shiner *Richardsonius balteatus*, sculpin *Cottus spp*., three-spined stickleback *Gasterosteus aculeatus* and Pacific lamprey *Entosphenus tridentatus*. (Mullan et al 1992, CCCD 2004, Wydoski and Whitney 2003).

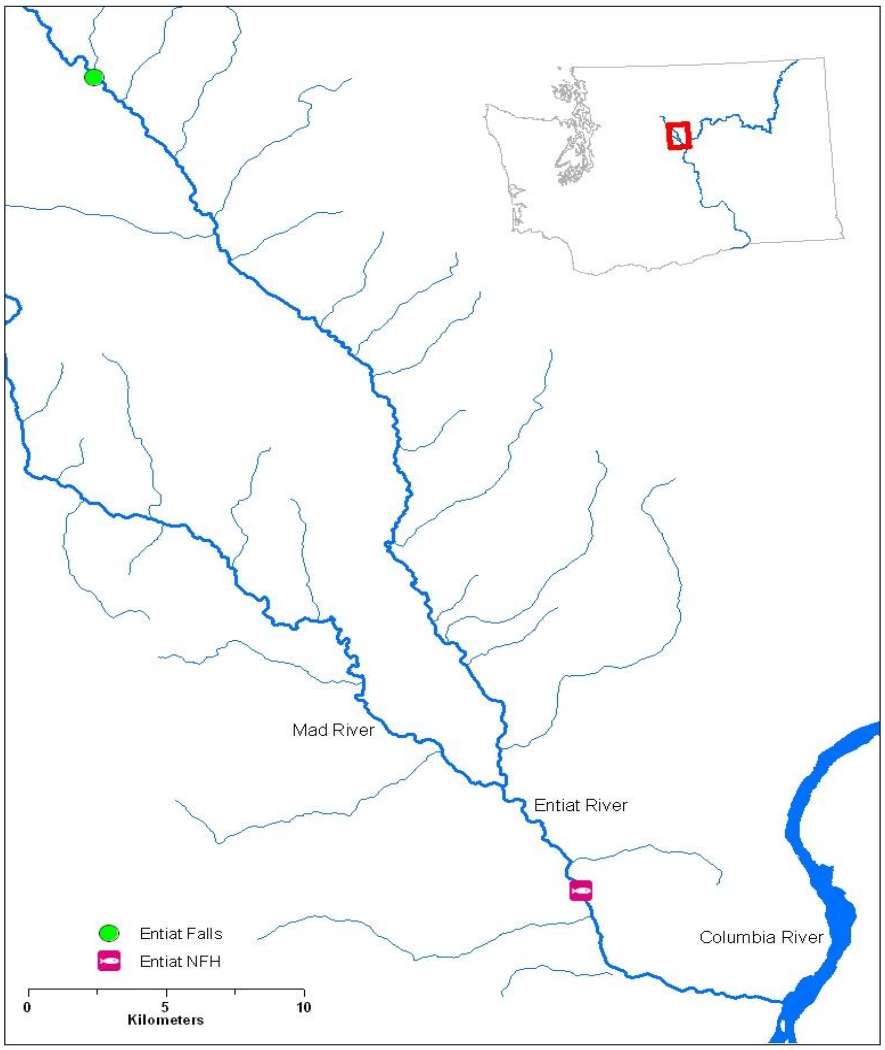

Figure 1. The Entiat River from its mouth to Entiat Falls at river kilometer 54.4

Methods-Rotary Screw Trap

Sites

The Mid-Columbia River Fishery Resource Office (MCRFRO) has been operating a rotary screw trap in the Entiat River at river kilometer (rkm) 11 adjacent to the Entiat National Fish Hatchery (ENFH) since 2003, and has captured juvenile fish at other sites within the Entiat Basin for Passive Integrated Transponder (PIT) tagging since 2005. In addition to the legacy collection sites, the MCRFRO added another rotary screw trap at rkm 2 during the 2007 field season (Figure 2).

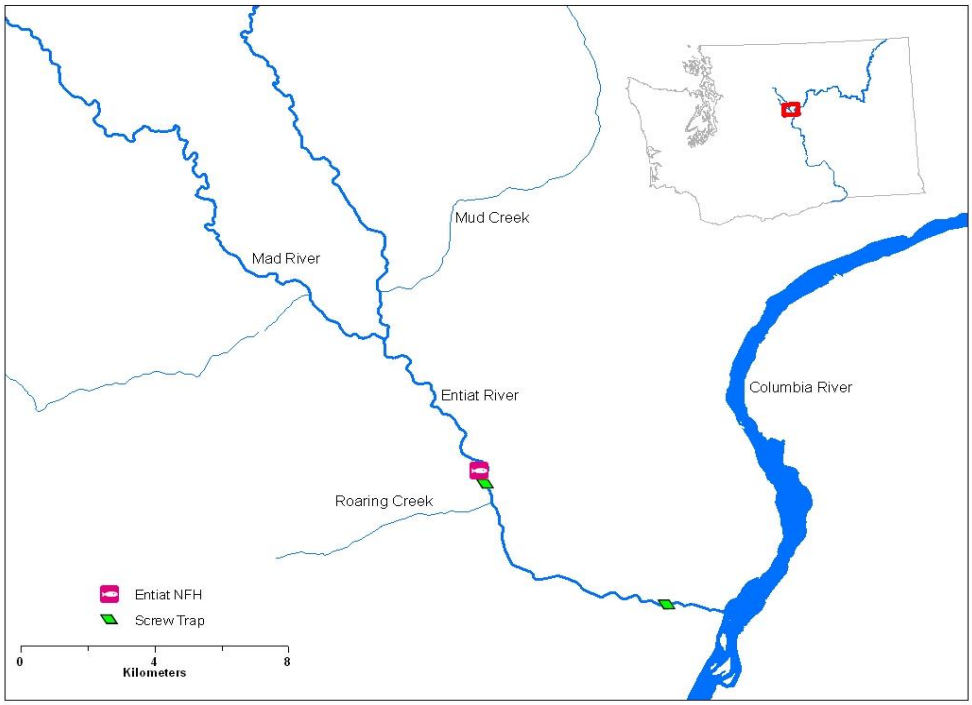

Figure 2. Study reach map of the Entiat River watershed with the juvenile rotary screw trap locations.

Rotary screw trap operation

Juvenile trapping methodologies are discussed annually amongst a variety of agencies conducting trapping programs in the upper Columbia River Basin. The results of these discussions have resulted in a trapping protocol that is applied basin-wide (Tussing, 2008).

Two modified 5 ft. diameter rotary screw traps manufactured by EG Solutions Inc. were used during this study to capture downstream migrating salmonids. The traps were retrofitted with pontoons from 8 ft. style screw traps to facilitate better floatation and safety in higher flow regimes. Additionally a debris door was placed on each trap cone and each trap was outfitted with a spray bar to pressure wash away accumulated algae that clogs the cone screen. Trap operations followed operational permit guidelines as per Chelan County Shoreline Management Act (file# SE 06-016 US Fish and Wildlife Service Fish Enhancement letter dated August 16, 2006), WDFW Temporary Use Permit (dated 11/27/07), and two Hydraulic Project Approvals (log#ST-F8213-01, upper trap dated 3/18/08 and control#112413-1, lower trap, dated 11/21/06). Assembled traps were lowered into the river via a boom truck and attached to ¼ inch aircraft cable that was anchored upstream to the base of large cottonwood trees. A bridge at the upper trap site and a cross cable at the lower trap site suspended the anchor cable above the stream from the anchor point to the trap. A system of winches and pulleys were utilized throughout the season to guide the trap within the river as flow regimes changed. Traps were assigned fixed positions based on flow. These positions were strictly adhered to in order to pool and statistically strengthen screw trap efficiencies. The traps operated seven days a week from March through November with allowances for some events. If possible,

traps were operated 24 hours a day; however, during spring high flows and increased debris loads the traps were operated from twilight to after sunrise. At times during extreme discharge events the traps were taken out of operation until such time that river conditions allowed reinitiating operations.

Fish handling

Fish handling procedures were conducted in accordance with WDFW Scientific Collection Permits #09-151, 155, 156 (dated 4/07/09), NOAA Permit 1119 (F/NWR3 dated 4/10/08) and USFWS Subpermit No. MCRFO-12 (dated 3/09/09).

At least once a day, juvenile fish were transported from the live box of each trap into 5 gallon buckets for tagging and biological sampling. The buckets were equipped with aerators, and a light salt (NaCl) solution (1 tbs/gal.) was added to minimize stress during transport and holding. The fish were transported to the ENFH, where a permanent, on-site electronic fish handling/tagging station has been built.

All fish species collected for biological sampling were anesthetized in a water bath with a measured amount of tricaine (MS-222) buffered with sodium bicarbonate to stage 3 or 4 as described in the Stages of Anesthesia by Summerfelt and Smith (1990). Small groups of fish were anesthetized at any one time during daily handling to reduce the chance of incidental mortality from anesthetic overdose. All fish were identified to species with the exception of sculpin, dace, and suckers. Attempts were made to further break Chinook salmon sub-yearling juveniles into run categories (spring, summer and unknown run). In previous years, spring and summer run designation was determined by a late summer nadir in Chinook salmon captures. Chinook salmon captured prior to the nadir were identified as summer run, and those captured after were called spring Chinook salmon. In February of 2008, a PIT tag interrogation site was installed and operational on the lower Entiat River. The data from this interrogation site clearly illustrated that our previous attempts to identify sub-yearling Chinook salmon were inadequate. Sub-yearling Chinook salmon not clearly identifiable by length at date criteria, were designated as wild Chinook salmon of unknown run to prevent misidentification.

In addition to species identification and Chinook salmon run classification, both steelhead and Chinook salmon were further ascribed to a life history stage as either fry (<60 mm), parr (>60 mm and distinctive parr marks), transitional (>60 mm silver sheen, faint parr marks) or smolt (>60 mm silver sheen with absent parr marks with possible black tipped caudal). Stage classification may provide a useful metric to gauge migratory readiness in juveniles and may help serve to separate resident "rainbow" from the migratory steelhead juveniles.

A minimum of 30 fish per species and life stage were measured to the nearest millimeter of fork length and all salmonids greater than 60 mm were weighed to the nearest tenth of a gram. After handling, all juveniles are allowed to fully recover prior to release. Non-tagged juveniles are released approximately 400 meters downstream from the trap of capture after a minimum one hour of recovery time.

PIT tagging of juvenile Chinook salmon, steelhead, and bull trout follows the procedures and file submission requirements outlined by Pacific State Marine Fisheries Commission PIT Tag Information System (PTAGIS) in addition to juvenile PIT tagging procedures described in the ISEMP Upper Columbia River Basin Protocol (Terraqua, 2008). Wild juvenile Chinook salmon, coho salmon, steelhead, cutthroat trout and bull trout greater than 60 mm of fork length were tagged using a disinfected hollow needle to insert the PIT tag (TX1411SST 134.2 kHz tags 12.5 mm/0.102 gm) into the abdominal cavity. ISEMP supplied PIT tags for ESA listed spring Chinook salmon and steelhead, Chelan County PUD provided tags for bull trout and the USFWS supplied PIT tags for cutthroat trout and coho salmon. All PIT tagged juveniles are measured to the nearest millimeter (mm) in fork length and weighed to the nearest tenth of a gram (gm) and any injuries noted. Juveniles are not PIT tagged if determined to have a recent or substantial injury that may become aggravated through tagging. PIT tagged juveniles were generally held 24 hrs at ENFH to monitor survival and tag retention. A maximum of 72 hours hold time was instituted on all tagged fish.

Data entry

All individual fish data entry utilized the P3 program from PTAGIS. P3 is a data entry application program required to collect and submit information about marked or recaptured fish with a PIT tag in the Columbia River Basin. USFWS utilized this program as a tool to enter all fish information regardless of whether or not the fish was marked with a PIT tag. P3 serves as a Microsoft Access™ overlay which allows communication with peripheral devices. USFWS peripheral devices included a Destron Fearing FS2001-ISO transceiver/antenna for reading PIT tags, a GTCO Calcomp DrawSlate VI digitizing board and a GSE 350 electronic balance for automating data entry into a laptop computer. Utilizing a custom Access™ database designed by Environmental Data Services (contact: Steve Rentmeester), P3 generated files could then be automatically parsed into the ISEMP database. The original P3 file was left intact and subsequently uploaded to PTAGIS. From this database, PIT tag information is parsed and housed for use by researchers throughout the Columbia River Basin.

Remote capture for PIT tagging

A large segment of PIT tagged fish are collected via rotary screw traps. However, the number of juvenile fish of minimum length (>60 mm) to be PIT tagged at the trap is generally short of the recommended 5,000 tagged steelhead/rainbow trout and 5,000 spring Chinook salmon needed from each sub-basin to effectively estimate life-stage survival rates (Hillman 2006). In addition, the rotary screw traps capture only migrating juveniles. The data obtained via PIT tag monitoring represent movement and survival outside of the Entiat Basin, as these juveniles migrate through the Columbia River hydro-corridor to the ocean. To increase the number of tagged fish and to improve information regarding within basin survival and migration timing, non-migratory juvenile spring Chinook salmon and steelhead rearing within the watershed were targeted for capture and subsequent tagging. As part of a pilot study to determine the efficacy of remote capture techniques to be used in the Entiat Intensively Monitored Watershed (IMW); USFWS and Terraqua joined efforts to increase “remote tagging” effort on the Entiat River and its main tributary, the Mad River.

Remote tagged steelhead and Chinook salmon were primarily caught using angling, electro-fishing and snorkel herding. Angling capture consisted of single barbless flies (size 14 and smaller) on light fly fishing gear. Snorkel herding utilized a team of in-stream snorkelers and a beach seine net to target and capture juvenile salmonids. Remote capture and PIT tagging activities were limited to temperature regimes below 18° C. Collected juveniles were tagged and released near their capture location. A proportion of remote tagged fish were held for 24 hours in mid-stream live-boxes to monitor tag retention and survival.

Genetic and scale sampling

Throughout the migration, a subset of captured bull trout, cutthroat, yearling and sub-yearling Chinook salmon and steelhead juveniles were sampled for genetic and age analysis, as per the Upper Columbia River Monitoring Strategy (Hillman 2006). This type of sampling is non-lethal. Genetic sampling involved taking a small clip of tissue from either the ventral (steelhead, cutthroat trout & spring Chinook salmon) or caudal fin (bull trout) and scales were collected from steelhead only. Steelhead scales were sent to the WDFW Office in Wenatchee and Chinook salmon, cutthroat trout, steelhead and bull trout tissue were sent to the Region 1 USFWS genetics lab for future analysis.

Screw trap efficiency

A portion of the collected Chinook salmon and steelhead were used to estimate trap capture efficiency. Captured fish were pooled for up-to 72 hours and released upstream of the capture origin. All fish used for efficiency trials were either PIT tagged (>60 mm FL) or dye marked (<60 mm FL) with Bismark brown. Marked fish were placed in a live box located at ENFH for holding (<72 hrs) prior to release. Marked fish were transported to release sites using 5 gallon buckets with aerators to minimize stress. Juvenile fish used for efficiency trials were released at twilight upstream of each trap. The release location for the upper trap was located primarily at rkm 18 (Mad River road bridge) for the upper trap and rkm 2.3 (Keystone Ranch private bridge) for the lower trap site. PIT tagged recaptured fish were subsequently re-measured and released to document growth rates since time of first capture. Fish recaptured at the same trap twice were removed from the daily catch estimate.

Water temperature and discharge

Water temperatures were measured with analog instruments. Discharge was monitored by USGS station number 12452990, located at rkm 2.3.

Results-Rotary Screw Trap/Remote

Trap operation time

The trapping sites were unchanged from 2008 with the lower and upper sites located at river kilometers 2 and 11, respectively. The upper rotary screw trap began operation on February 26th, 2009. The persistence of ice at the lower trapping location resulted in the inability to operate the rotary screw trap until March 18th. Both rotary screw traps were operated on a seven day per week schedule through November 16th, 2009 excluding some

holidays and extreme discharge events. Of the 245 trapping days available within the season the lower trap operated 175 (71.4%) complete days (uninterrupted sampling from sunset to sunrise). The upper trap, with 264 trapping days available, operated 208 (78.9%) complete days.

Rotary screw trap target species capture summary
In 2009 a total of 38,351 fish were captured within the rotary screw traps (Table 1). The total capture consisted of 27,442 Chinook salmon (71.55%), 2,972 steelhead trout (7.75%), 103 coho salmon (0.27%), 21 cutthroat trout (0.05%), 106 bull trout (0.28%), and 7,831 non-target species (including adult salmonids) (20.42%). A total of 12,082 wild salmonids were implanted with PIT tags. Detailed capture summaries including adult species are included as Appendix Table 2.

Remote tagging operations
A total of 2,760 fish were captured at remote locations spread throughout the Entiat and Mad river watershed. Juvenile species (generally less than 300mm fork-length) are targeted for this study and no adult species were incidentally captured in 2009. Captured species composition included; 1,232 steelhead (44.6%), 952 Chinook salmon (34.49%), 13 coho salmon (0.47%), 7 cutthroat trout (0.25%), 12 bull trout (0.43%) and 544 non-target species (19.71%). A total of 1,037 wild salmonids were implanted with PIT tags (Table 2, Appendix 3). A variety of methods (snorkel herding, angling, electro-fishing) for remote capture were utilized in 2009. Similar to previous years, angling was the most effective method to catch age 1+ steelhead, while sub-yearling Chinook salmon and steelhead dominated the catch from snorkel-herding and electro-fishing. By stream habitat type, angling proved to be the most productive method in boulder dominated riffles and steeper gradients such as those often encountered in the lower reaches of the Mad River. Conversely, snorkel-herding and electro-fishing tactics proved a reliable capture method in low gradient reaches, off channel habitat, and debris jams such as those found at various locations in the main stem Entiat River.

Trap efficiencies
A total of 14 viable rotary screw trap efficiency trials were conducted for spring Chinook salmon, and 7 trials were conducted for steelhead on the upper Entiat River rotary screw trap. Spring Chinook salmon efficiency averaged 28.21% and steelhead 11.76% respectively (Table 3). The lower rotary screw trap had 20 viable trials for spring Chinook salmon, and 8 trials for steelhead with an average capture efficiency estimated at 16.37%, and 13.82% (Table 4). There were other trials conducted during the study period, but these results were omitted due to fish health concerns, low release numbers, or incorrect trap position. All trap efficiency trials utilized PIT tagged transitional or smolt juveniles released after dusk to ensure individuals in the mark group were migratory.

ATM/PTAGIS upload
All data was uploaded into the PTAGIS database, and the MCRFRO database on a minimum weekly basis. All final uploads into the PTAGIS database were completed on December 7th, 2009.

Table 1. Target species capture and PIT tag results from the upper rotary screw trap (rkm 11) and the lower rotary screw trap (rkm 2) on the Entiat River.

Sampling Location	Species and Life Stage	Total number of fish caught	Total PIT tagged
Upper Rotary Screw Trap	Wild sub-yearling spring Chinook salmon	5,205	3,986
	Wild yearling spring Chinook salmon	1,419	1,222
	Wild summer Chinook salmon	6,007	0
	Wild coho salmon	14	4
	Wild steelhead	1,323	1,099
	Bull trout	63	54
	Wild cutthroat trout	13	13
	Non-target species	5061	0
	Total	**19,105**	**6,378**
Lower Rotary Screw Trap	Wild sub-yearling spring Chinook salmon	3,422	2,187
	Wild yearling spring Chinook salmon	1,532	1,048
	Wild summer Chinook salmon	9,758	2
	Wild coho salmon	83	60
	Wild steelhead	1,645	1,326
	Bull trout	43	37
	Wild cutthroat trout	8	7
	Non-target species	2,755	0
	Total	**19,246**	**4,667**

Table 2. Entiat and Mad Rivers salmonid remote capture and PIT tag results.

Species and Life Stage	Total number of fish caught	Total PIT tagged	Total recaptured at initial capture site
Wild sub-yearling spring Chinook salmon	---	---	---
Wild yearling spring Chinook salmon	---	---	---
Wild summer Chinook salmon	---	---	---
Wild sub-yearling Chinook salmon (unk. run)	952	327	82
Wild coho salmon	13	2	0
Wild steelhead	1,232	689	36
Bull trout	12	12	0
Wild cutthroat trout	7	7	0
Total	**2,216**	**1,037**	**118**

Table 3. **Upper Entiat River (rkm 11.0) rotary screw trap spring efficiency trial results.**

Spring Chinook salmon			Steelhead		
Trial Day 1	**Avg CFS**	**Recap. %**	**Trial Day 1**	**Avg CFS**	**Recap. %**
03/20/2009	143	44.74	04/22/2009	587	10.00
03/23/2009	158	34.29	04/25/2009	732	12.77
03/30/2009	162	37.61	05/05/2009	639	7.89
04/15/2009	298	15.24	05/08/2009	657	13.21
04/18/2009	317	11.46	05/11/2009	654	10.00
04/22/2009	587	16.96	05/14/2009	792	15.63
04/25/2009	732	18.60	05/17/2009	740	12.82
09/29/2009	119	43.08			
10/11/2009	83	30.77			
10/15/2009	103	47.66			
10/29/2009	171	25.33			
11/05/2009	231	15.05			
11/08/2009	223	31.01			
11/12/2009	211	23.17			

Table 4. **Lower Entiat River (rkm 2.0) rotary screw trap spring efficiency trial results.**

Spring Chinook salmon			Steelhead		
Trial Start	**Avg CFS**	**Recap. %**	**Trial Start**	**Avg CFS**	**Recap. %**
03/27/2009	159	10.87	04/20/2009	349	6.17
04/06/2009	164	37.04	04/23/2009	788	10.14
04/07/2009	173	25.93	04/26/2009	654	11.24
04/11/2009	266	17.14	04/28/2009	596	15.15
04/14/2009	305	14.62	04/30/2009	537	15.91
04/17/2009	293	22.63	05/03/2009	527	31.03
04/20/2009	349	19.70	05/06/2009	647	6.94
04/23/2009	788	7.88	05/15/2009	771	13.92
04/26/2009	654	14.47			
09/23/2009	133	7.69			
10/09/2009	78	16.96			
10/17/2009	83	14.91			
10/28/2009	188	8.64			
11/02/2009	282	18.45			
11/05/2009	231	20.00			
11/07/2009	237	9.32			
11/09/2009	236	24.82			
11/12/2009	211	14.12			
11/13/2009	187	8.62			
11/15/2009	190	13.68			

Discussion- Rotary Screw Trap

Rotary screw trap operation

The day to day operation of rotary screw traps can pose some difficulty. The traps are at the mercy of the watershed at all times while suspended in the stream. Alterations in flow regime and/or weather events can cause debris to pile up on or in the rotary screw trap. This can create a hazardous work environment for the crew, increase the trap related mortality of captured fish, and cause damage to traps and capture-related equipment. To alleviate these potential hazards, traps were pulled when deemed necessary. During this study the majority of days missed from sampling were due to high spring flow events and fall wind events in late October and November, which inundated the traps with leaves and other debris. Sporadic trap repairs and mechanical failures contributed to the remaining trapping days lost.

Summer vs. spring Chinook salmon

Both spring and summer Chinook salmon spawn in the Entiat basin. Early in the season, distinct morphological differences between summer sub-yearlings and spring Chinook salmon yearlings make identification easy. During this period spring Chinook salmon yearlings are much larger in size (75-100 mm) in comparison to newly emergent summer Chinook fry (32-45 mm). Identification becomes much more difficult during summer and early fall as both spring and summer Chinook sub-yearlings are of similar lengths and condition. Currently, a definitive method to apportion these two runs of sub-yearlings is problematic and unverified. In order to tease out the difference in migration timing, total catch was monitored and plotted by day. When catch dwindled and a relative nadir was reached in early September, all Chinook salmon captured onward were identified based on any detectable break in fork length distributions. Undoubtedly, some Chinook salmon were identified improperly using this method. This was further illustrated after the installation of stream-width PIT tag interrogation sites in the Entiat basin. Utilizing the data from these interrogation sites and the emigration timing of PIT tagged Chinook salmon it became clear that delineation of the two runs of sub-yearling Chinook salmon used in previous years was inadequate. To alleviate this potential improper identification, sub-yearling Chinook salmon PIT tagged after the spring migration were identified as wild Chinook salmon of unknown run in 2008. Based on continued and real-time analysis of PIT tag interrogation data, the previous nadir based identification method was again utilized for the 2009 field season. The USFWS did not employ the wild Chinook salmon of unknown run designation for rotary screw trap results in 2009. It appears that the nadir approach will be continued until a better alternative is identified.

Project goals

Project goals were met during the 2009 field season. Continued out-migrant monitoring is required both at the rotary screw traps and within the basin in order to evaluate the success of wild steelhead and spring Chinook salmon. This is especially relevant to monitor the effects of the discontinued propagation of spring Chinook salmon at the ENFH which ended in 2007. Additonally, migrant trapping will facilitate the implementation of the Intensively Monitored Watershed (IMW) study which is scheduled for the 2010 field season.

Methods- Snorkel Surveys

Fish were surveyed by direct observation using single-pass snorkeling method as described in Murdoch and Nelle (2008) and by Thurow (1994).

Snorkel site selection
Snorkel site locations were identified jointly by USFWS and Terraqua, Inc. Site locations were defined by using locations of proposed habitat structures (treatment sites), locations of existing habitat structures (pre-existing treatment sites), and information from Rosgen stream typing classification methods to select sites with a similar channel types as treatment sites for sites not subject to modifications (control sites). Treatment and pre-existing treatment sites were setup to place the area surveyed in the middle of the section to be modified or presently modified. Snorkel sites were defined to be 200 m in length in the main river sites and 240 m or less in off-channel sites. Each site was further divided into habitat units, monumented, and flagged.

Snorkel surveys
Snorkel surveys took place during two time periods in 2009. The winter survey occurred during March and the summer survey took place in August. These times of the year have low water flows which allow for good visibility and snorkeling conditions. The winter survey was conducted at night while the summer survey occurred during daylight hours. Night snorkeling began when the first star was observed in the sky, or 30 minutes past the official sunset at Entiat, Washington. The summer snorkels usually began around 10:00 AM.

Drysuits, gloves, a mask, and a snorkel were used by each snorkeler. Dive lights were used during night snorkeling for illumination. Water temperature was taken at the start and end of each individual snorkel. A turbidity sample was also taken from each site. A measurement of visibility was acquired by the distance a snorkeler could identify a 10 centimeter (cm) rainbow trout fish lure (Rapala Model #XRD-10RT) as a fish. Up to 8 snorkelers were spaced evenly across the river so that the whole river was in view. There was also up to 2 walkers along the bank. Fewer surveyors were used in narrow sections of the river and in side-channels. Snorkelers entered the water downstream of the survey site and conducted the survey in an upstream manner. Snorkelers recorded fish upstream and/or to their left. Walkers on the bank recorded fish in areas that were too shallow to snorkel. All fish were identified to species and total length was recorded in 2 cm size classes. Information was recorded onto data boards while snorkeling and was then transferred to data sheets at the end of each habitat unit.

Results- Snorkel Surveys

Snorkel sites
Thirty sites were snorkeled during each of the snorkel periods (Table 5). These sites were the same as those snorkeled in 2008. The Knapp-Wham and Hanan-Detwiler ditches were dewatered during the winter snorkel and were not surveyed.

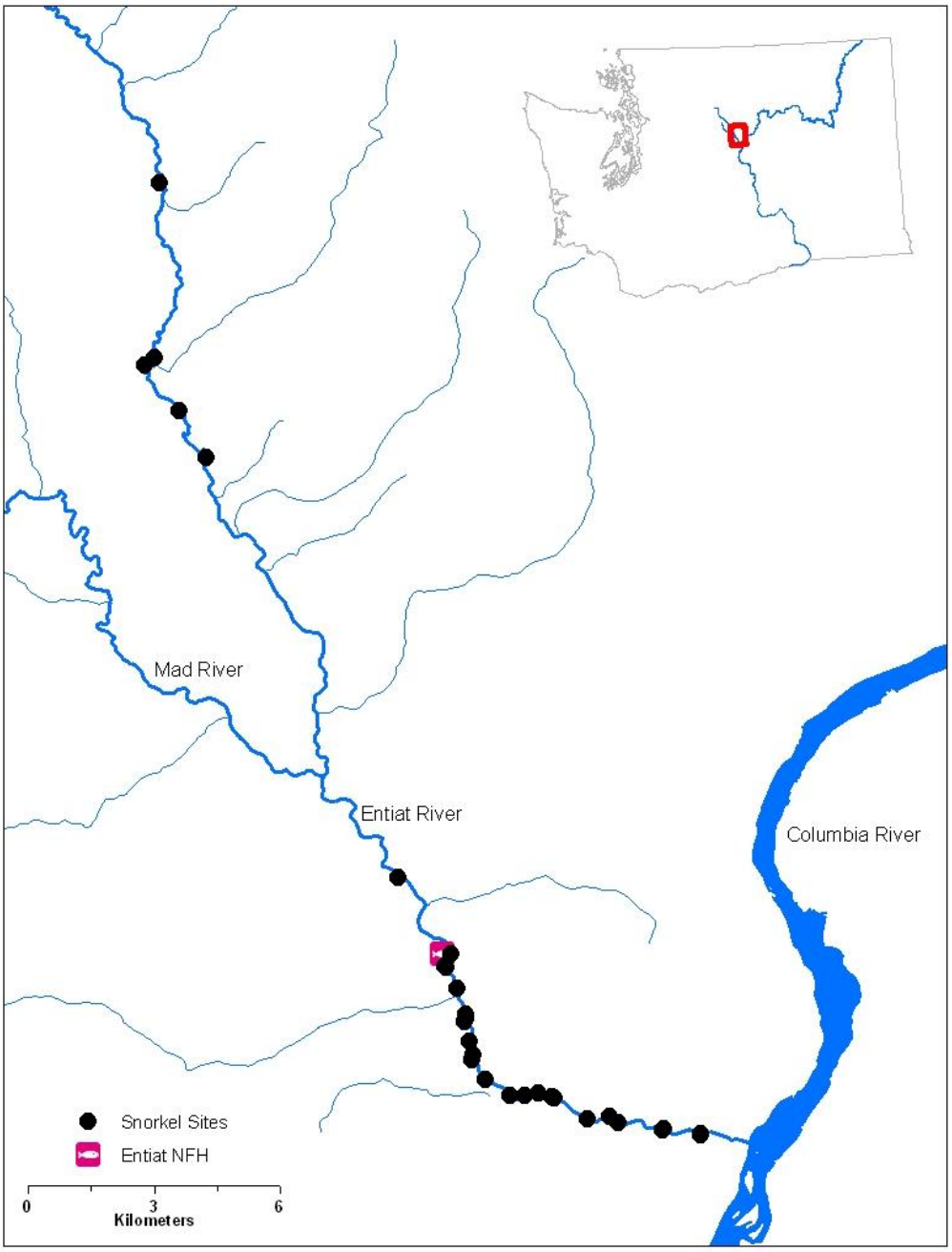

Figure 3. The snorkel sites on the Entiat River for the winter and summer periods, 2009.

Table 5. The snorkel sites for both the 2009 winter and summer snorkels in the Entiat River.

Site Name	Experimental Site Type	Channel Location	River Kilometer (km)	Site Length (m)	Mid-point Coordinates	
					Latitude (N)	Longitude (W)
City Limits Main	Control	Main	0.5	200	47.66320	120.23643
City Limits Side	Control	Off	0.5	200	47.66320	120.23643
Split Channel North	Treatment	Main	2.3	200	47.66293	120.24875
Split Channel South	Treatment	Main	2.3	200	47.66274	120.24916
Foreman Statues	Control	Main	3.5	200	47.66477	120.26286
Keystone Canyon	Treatment	Main	3.7	200	47.66528	120.26584
Milne	Treatment	Main	4.3	200	47.66546	120.27232
Whitehall Cross Vane	Treatment	Main	5.5	200	47.66920	120.28440
PUD Side	Treatment	Off	5.5	240	47.66860	120.28298
Harrison Lower Side	Treatment	Off	6	200	47.67064	120.28817
Harrison Pond	Treatment	Off	6.1	200	47.66993	120.29232
Harrison Main	Treatment	Main	6.4	200	47.66993	120.29232
Harrison Upper	Control	Main	6.4	200	47.66944	120.29823
Dinkelman Cross Vane	Existing Treatment	Main	7.4	200	47.67207	120.30595
Stanton-Love	Treatment	Main	8.4	200	47.67761	120.31252
Hanan-Detwiler Ditch	Control	Off	8.4	200	47.67616	120.31201
Jon Small Barbs	Existing Treatment	Main	8.8	200	47.68088	120.31263
Knapp-Wham Lower	Control	Main	9.3	200	47.68453	120.31426
Knapp-Wham Ditch	Control	Off	9.3	100	47.68609	120.31564
Knapp-Wham Upper	Treatment	Main	9.5	200	47.68507	120.31535
Moen	Treatment	Off	10	200	47.69201	120.31679
Wilson Main	Control	Main	10.6	200	47.69548	120.32093
Wilson Side	Existing Treatment	Off	10.6	200	47.69606	120.32128
Hatchery	Control	Main	10.7	200	47.69869	120.32396
Powerline	Control	Main	13.2	200	47.71498	120.33564
CDLT Moraine	Control	Main	26.5	200	47.80231	120.40202
Deskin/Wortz	Existing Treatment	Main	28	200	47.81224	120.41138
Lower Stormy	Control	Main	29.4	200	47.22001	120.42350
Upper Stormy	Treatment	Main	29.8	200	47.82387	120.42124
Sego-Yurt	Treatment	Main	34.4	200	47.86131	120.42066

Temperature

Average water temperatures for individual snorkel reaches during the winter varied between 1.75° and 7°C (Table 6, 7). The average water temperature for the entire period was 4.1°C (SD 1.6). During the summer snorkel, average water temperatures for individual reaches ranged from 13.25° to 21°C. The average water temperature for the entire period was 16.8°C (SD 1.9).

Table 6. **Water quality characteristics for each snorkel site during the winter 2009 snorkel period. Discharge is taken from the USGS gage station near Entiat.**

Snorkel Period-Snorkel Time	Site Name	River Kilometer (km)	Snorkel Date	Discharge (ft^3/sec)	Average Temperature °C	Turbidity NTU
Winter- Night	City Limits Main	0.5	3/12/2009	137	3	0.66
	City Limits Side	0.5	3/12/2009	137	3	0.66
	Split Channel North	2.3	3/17/2009	148	6.5	0.69
	Split Channel South	2.3	3/17/2009	148	7	0.49
	Foreman Statues	3.5	3/08/2009	161	4.5	0.64
	Keystone Canyon	3.7	3/08/2009	161	4.5	0.87
	Milne	4.3	3/08/2009	161	4	0.47
	Whitehall Cross Vane	5.5	3/11/2009	131	2	0.46
	PUD Side	5.5	3/11/2009	131	2	0.46
	Harrison Lower Side	6	3/18/2009	145	6	0.45
	Harrison Pond	6.1	3/18/2009	145	6.25	0.45
	Harrison Main	6.4	3/10/2009	149	3	0.36
	Harrison Upper	6.4	3/10/2009	149	2.75	0.36
	Dinkelman Cross Vane	7.4	3/11/2009	131	3	0.55
	Stanton-Love	8.4	3/09/2009	158	2.75	0.4
	Hanan-Detwiler Ditch	8.4	3/18/2009	145	No Water	
	Jon Small Barbs	8.8	3/12/2009	137	3.75	0.55
	Knapp-Wham Lower	9.3	3/09/2009	158	4	0.36
	Knapp-Wham Ditch	9.3	3/18/2009	145	No Water	
	Knapp-Wham Upper	9.5	3/09/2009	158	3.75	0.36
	Moen	10	3/17/2009	148	6.5	N/A
	Wilson Main	10.6	3/11/2009	131	2	0.44
	Wilson Side	10.6	3/17/2009	148	6.75	1.59
	Hatchery	10.7	3/10/2009	149	1.75	0.49
	Powerline	13.2	3/12/2009	137	3	0.67
	CDLT Moraine	26.5	3/16/2009	150	5	0.3
	Deskin/Wortz	28	3/16/2009	150	5	0.45
	Lower Stormy	29.4	3/16/2009	150	5	0.37
	Upper Stormy	29.8	3/16/2009	150	5	0.37
	Sego-Yurt	34.4	3/16/2009	150	4	0.32

Discharge

The United States Geological Survey (USGS) gage on the Entiat River (rkm 2.3) recorded discharges ranging from 125 to 161 $feet^3$/second (cfs) during the winter and summer snorkel surveys. Both surveys occurred during low flow periods of the year (Fig 4). The winter snorkel took place during a period of decrease, increase and then slight decrease in the hydrograph. The cfs at the start of the survey was 161; it then dropped to 131 in the middle of the survey period before rising slightly to 145 at the end (Fig 5). The summer survey was conducted during a drop in the hydrograph, falling from 158 to 125 cfs over the survey period (Fig 6).

Table 7. **Water quality characteristics for each snorkel site during the summer 2009 snorkel period. Discharge is taken from the USGS gage station near Entiat.**

Snorkel Period-Snorkel Time	Site Name	River Kilometer (km)	Snorkel Date	Discharge (ft^3/sec)	Average Temperature °C	Turbidity NTU
Summer- Day	City Limits Main	0.5	8/10/2009	158	21	0.63
	City Limits Side	0.5	8/10/2009	158	20	N/A
	Split Channel North	2.3	8/18/2009	125	16.75	0.58
	Split Channel South	2.3	8/18/2009	125	17.25	0.58
	Foreman Statues	3.5	8/11/2009	151	17.5	0.51
	Keystone Canyon	3.7	8/11/2009	151	18.5	0.51
	Milne	4.3	8/11/2009	151	18.75	0.72
	Whitehall Cross Vane	5.5	8/14/2009	150	14	0.53
	PUD Side	5.5	8/14/2009	150	13.25	0.53
	Harrison Lower Side	6	8/18/2009	125	16	0.83
	Harrison Pond	6.1	8/18/2009	125	19.5	1.1
	Harrison Main	6.4	8/17/2009	134	15	0.46
	Harrison Upper	6.4	8/17/2009	134	15	0.47
	Dinkelman Cross Vane	7.4	8/14/2009	150	14.75	0.5
	Stanton-Love	8.4	8/12/2009	155	17.75	0.74
	Hanan-Detwiler Ditch	8.4	8/18/2009	125	18	0.7
	Jon Small Barbs	8.8	8/17/2009	134	17.5	0.52
	Knapp-Wham Lower	9.3	8/13/2009	152	15.5	0.7
	Knapp-Wham Ditch	9.3	8/18/2009	125	N/A	N/A
	Knapp-Wham Upper	9.5	8/13/2009	152	16.5	0.7
	Moen	10	8/18/2009	125	N/A	0.73
	Wilson Main	10.6	8/14/2009	150	15.75	0.45
	Wilson Side	10.6	8/12/2009	155	19	4.65
	Hatchery	10.7	8/12/2009	155	17.25	0.45
	Powerline	13.2	8/13/2009	152	16.5	0.64
	CDLT Moraine	26.5	8/10/2009	158	17.25	0.55
	Deskin/Wortz	28	8/18/2009	125	15.5	0.52
	Lower Stormy	29.4	8/10/2009	158	16	0.52
	Upper Stormy	29.8	8/10/2009	158	16.25	0.52
	Sego-Yurt	34.4	8/18/2009	125	14	0.37

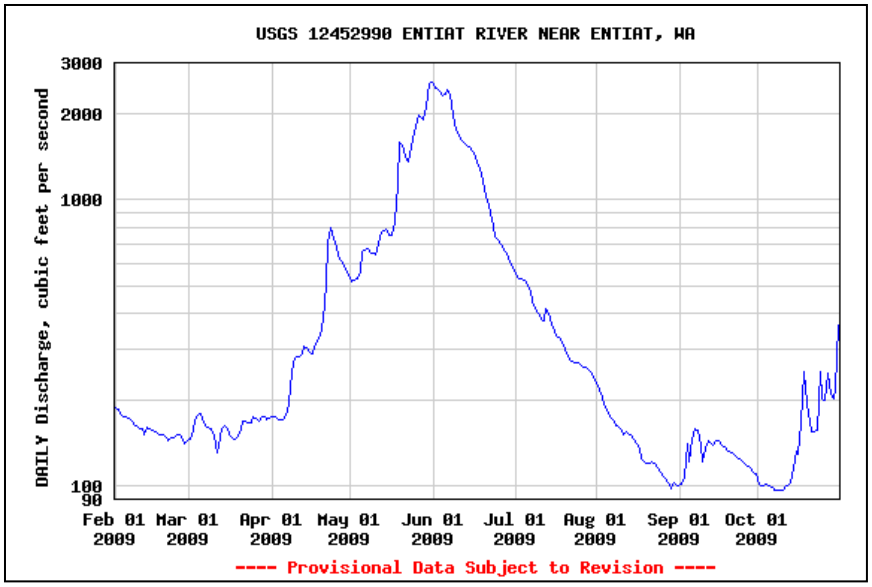

Figure 4. The daily discharge of water in feet^3/second (cfs) of the Entiat River during 2009.

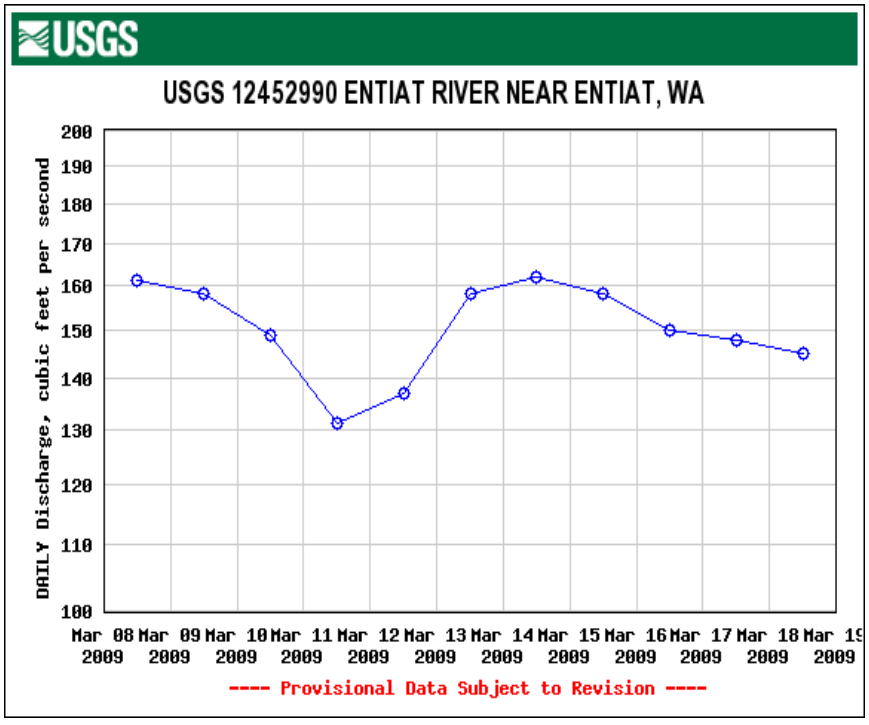

Figure 5. The daily discharge in feet^3/second (cfs) of the Entiat River during the winter 2009 snorkel period.

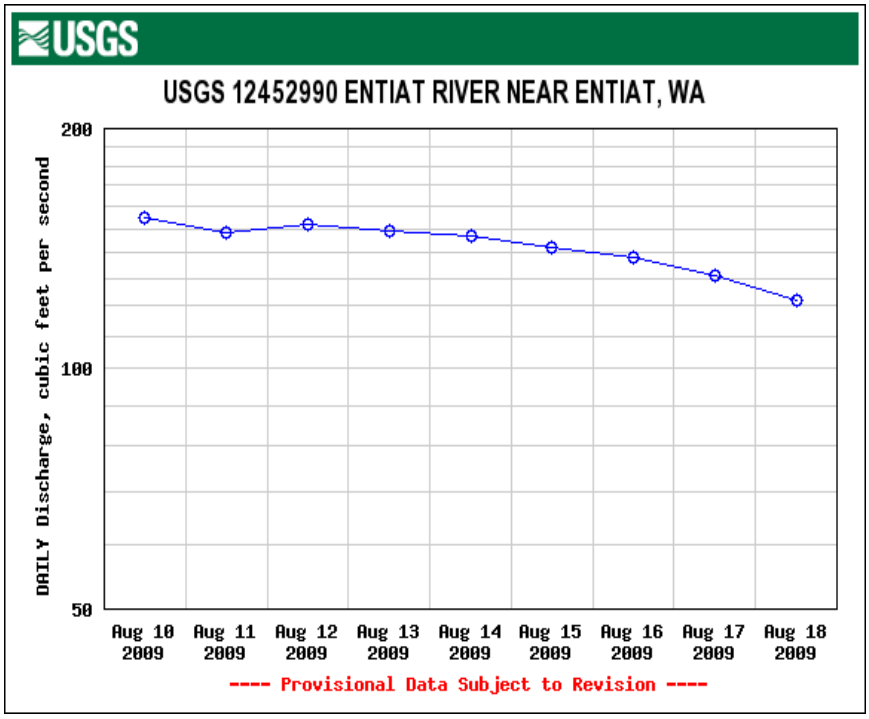

Figure 6. The daily discharge in feet^3/second (cfs) of the Entiat River during the summer 2009 snorkel period.

Turbidity

The turbidity during the winter survey ranged from 0.3 to 1.59 NTU with a mean of 0.53 NTU (SD 0.25) (Table 6). The turbidity of the summer survey ranged from 0.63 to 4.65 NTU with a mean of 0.74 NTU (SD 0.78) (Table 7). The turbidity of the main channel averaged 0.48 NTU (SD 0.15) for winter and 0.55 NTU (SD 0.10) for summer. Side channel turbidity was higher than the main channel during both surveys (average 0.72 NTU, SD 0.49 for winter and 1.42 NTU, SD 159 for summer).

Fish counts

A total of 50,282 fishes were counted during the 2009 winter and summer snorkels. The majority of these (48,223) were seen during the summer, while 2,059 were observed during the winter snorkel. Rainbow trout/steelhead were the most abundant during the winter snorkel (1,342), comprising 65% of the total number observed. Chinook salmon, mountain whitefish, and sculpin spp. were the next most abundant during the winter with counts of 424, 178, and 42 respectively. Mountain whitefish were the most observed fish during the summer with a count of 10,633 (22%). Chinook salmon, rainbow trout/steelhead, dace spp., coho salmon, and sucker spp. were the next most observed fishes with counts of 7,953, 7,705, 7,468, 2,693, and 1,159 respectively. Mountain whitefish were the most abundant overall (10,811), followed by rainbow trout/steelhead (9,047) and Chinook salmon (8,377). Five bull trout were seen during the winter snorkel and 7 were observed during the summer snorkel (Table 8). A total of 10,232 fish of unknown species were seen. Most of these were juvenile or larval fish (1-3 cm in size) observed in shallow areas that were difficult to snorkel. One salamander and 15 tadpoles were also observed in the Moen site during the summer snorkel.

Table 8. **The numbers of each species of fish observed during winter and summer snorkels in the Entiat River during 2009.**

Fish Species	Winter (Night)	Summer (Day)	Total
Bull trout	5	7	12
Chinook salmon	424	7,953	8,377
Chiselmouth	1	2	3
Coho salmon	6	2,693	2,699
Cutthroat trout	0	2	2
Dace spp.	24	7,468	7,492
Lamprey spp.	3	0	3
Mountain whitefish	178	10,633	10,811
Northern pikeminnow	0	4	4
Red side shiner	0	57	57
Sculpin spp.	42	220	262
Sockeye salmon	0	3	3
Steelhead/rainbow trout	1,342	7,705	9,047
Sucker spp.	20	1,159	1,179
Three-spine stickleback	1	98	99
Unknown	13	10,219	10,232
Grand Total	**2,059**	**48,223**	**50,282**

Discussion- Snorkel Surveys

Snorkel surveys were conducted during low water flows and when water clarity provided good visibility, ensuring that snorkels were conducted on time and within their given time periods. Project goals were reached for the 2009 snorkel season.

Methods- Steelhead Redd Surveys

Redd surveys for steelhead were conducted on the Entiat River during the spring of 2009. Redd surveys were conducted and data was recorded using methods described in Nelle and Moberg (2008). The area surveyed encompassed the entire main-stem river from Fox Creek campground at river kilometer (rkm) 45 downstream to the Entiat city limits at rkm 1.1. The survey area was broken into four reaches based on river access points and distances that could be surveyed in a work day. Reach A, 9.5 km long, extended from the Entiat city limits (rkm 1.1) to the ENFH (rkm 10.6). Reach B was 15.3 km in length, covering the river from rkm 10.6 to the McKenzie diversion dam at rkm 25.9. Reach C went from the McKenzie diversion dam (rkm 25.9) to a private bridge upstream of Brief (rkm 37.7) for at total length of 11.8 km. Reach D was 7.3 km in length and began at rkm 37.7 and was extended past the previous years' endpoint of rkm 44.2 to include the section of river upstream to Fox creek campground at rkm 45 (Figure 7). Conditions permitting, all four reaches were surveyed once each week. Surveys were conducted in a

downstream direction using two 10 foot personal rafts and walking when areas were inaccessible or too dangerous for rafts.

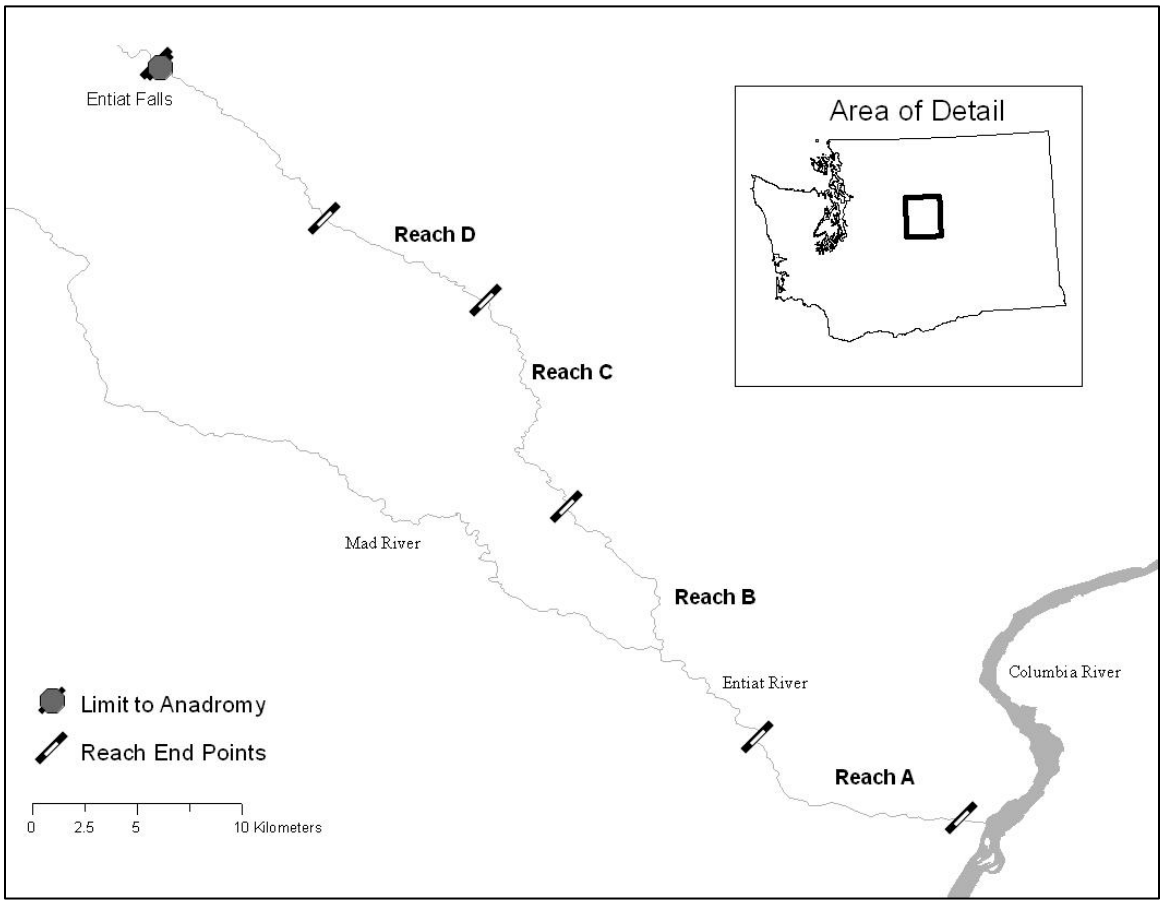

Figure 7. The four reaches of steelhead redd surveys on the Entiat River, 2009.

Results- Steelhead Redd Surveys

Surveys began on February 13, 2009 and concluded on June 25, 2009. No surveys were conducted during late May and most of June as high water and turbidity prevented surveyors from seeing redds. A total of 200 redds were observed. Zero counts were achieved on the first survey in each reach except reach D which was not conducted until April 8 due to weather conditions (Table 9). The first redd was observed during the week of March 25 in reach C. Redds were found in one or more of the reaches until the week of May 13 when the last new redds were observed. No new redds were observed during or after the high flow spring runoff which occurred in mid May and continued through mid June (Figure 8). Downstream of the ENFH, in reach A, 128 redds (64%) were found (Figure 9). In reach B 37 redds (19%) were observed (Figure 10), 27 (14%) were found in reach C (Figure 11), and 8 (4%) were found in reach D (Figure 12). This distribution is similar to previous years' surveys with more redds observed in the lower reaches than the upper reaches (Table 10). In reach A 31 redds (24%) were observed within restoration

sites. The number of redds observed within restoration areas was less than in previous years. In 2008 45 (48%) and in 2007 11 (28%) of the redds in reach A were within restoration sites (Table 11). In reach B, 8 (22%) of the 37 redds were in irrigation diversions. Two (25%) of the 8 redds in reach D were in the artificial spawning channel located at rkm 44.2.

Table 9. The weeks and number of new redds observed during steelhead spawning ground surveys in the Entiat River, 2009. Blank spaces indicate that surveys for that reach had not yet begun. An N/A means that a survey was not conducted in that reach due to high turbidity or other preventing factor.

Survey Week	Mid-Week Date	Reach A		Reach B		Reach C		Reach D		All Reaches	
		New	Total	New	Total	New	Total	New	Total	New	Total
1	02/11/09	0	0							0	0
2	02/18/09	0	0	0	0					0	0
3	02/25/09	0	0	0	0					0	0
4	03/04/09	0	0	0	0					0	0
5	03/11/09	0	0	0	0					0	0
6	03/18/09	0	0	0	0	0	0			0	0
7	03/25/09	0	0	0	0	1	1			1	1
8	04/01/09	4	4	0	0	2	3			6	7
9	04/08/09	14	18	4	4	1	4	1	1	20	27
10	04/15/09	2	20	3	7	12	16	1	2	18	45
11	04/22/09	20	40	3	10	1	17	2	4	26	71
12	04/29/09	14	54	11	21	N/A	17	N/A	4	25	96
13	05/06/09	53	107	11	32	7	24	1	5	72	168
14	05/13/09	21	128	5	37	3	27	3	8	32	200
15	05/20/09	N/A	128	N/A	37	0	27	N/A	8	0	200
16	06/24/09	0	128	0	37	0	27	0	8	0	200

Table 10. The number of steelhead redds observed by reach on the Entiat River from 2006 to 2009.

Year	Reach				
	A	B	C	D	Total
2006	38	26	34	13	111
2007	40	7	14	3	64
2008	93	84	31	14	222
2009	128	37	27	8	200

Table 11. **The total number of redds observed in the immediate vicinity of restoration sites along the Entiat River below river kilometer 10.6 during 2007-2009.**

Survey Year	2009	2008	2007
Total Redds Observed	200	222	60
Redds above Hatchery	72	129	21
Redds below Hatchery	128	93	39
Hatchery to Dinkelman Cyn. Rd.			
John Small Barb	0	0	0
Hanan/Detwiler Cross Vane	5	9	9
Rest of the Section	32	31	17
Total Redds	37	40	26
Dinkelman Cyn. Rd. to Fire Station			
Dinkelman Cyn. Rd. Cross Vane	2	3	0
PUD Irrigation Ditch	2	4	0
Whitehall Cross Vane	1	4	0
Rest of the Section	15	6	0
Total Redds	22	17	0
Fire Station to U.S.G.S.			
Fire Station Cross Vanes	6	1	0
Milne Irrigation Diversion	15	24	3
Rest of the Section	10	2	4
Total Redds	30	27	7
U.S.G.S. to Columbia River Confluence	39	9	6
Total Redds	39	9	6

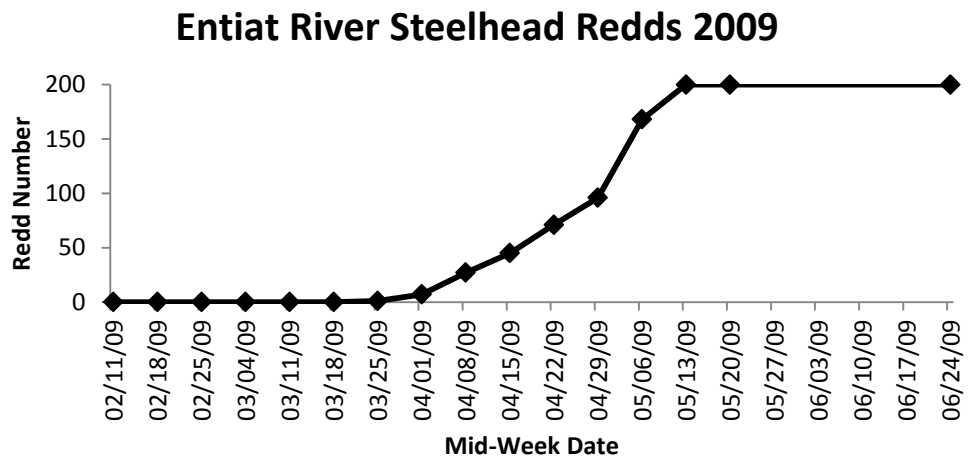

Figure 8. The total number of steelhead redds observed by week in the Entiat River during 2009.

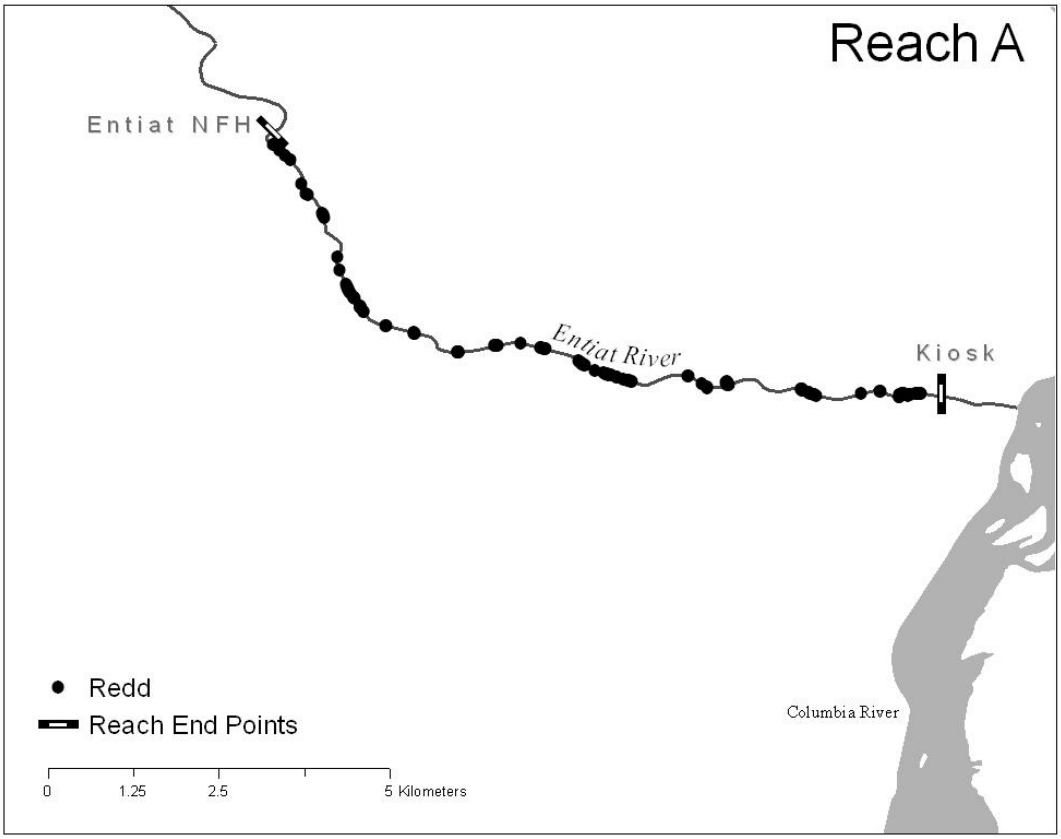

Figure 9. Steelhead redds observed on reach A (rkm 1.1 - 10.6) of the Entiat River during 2009.

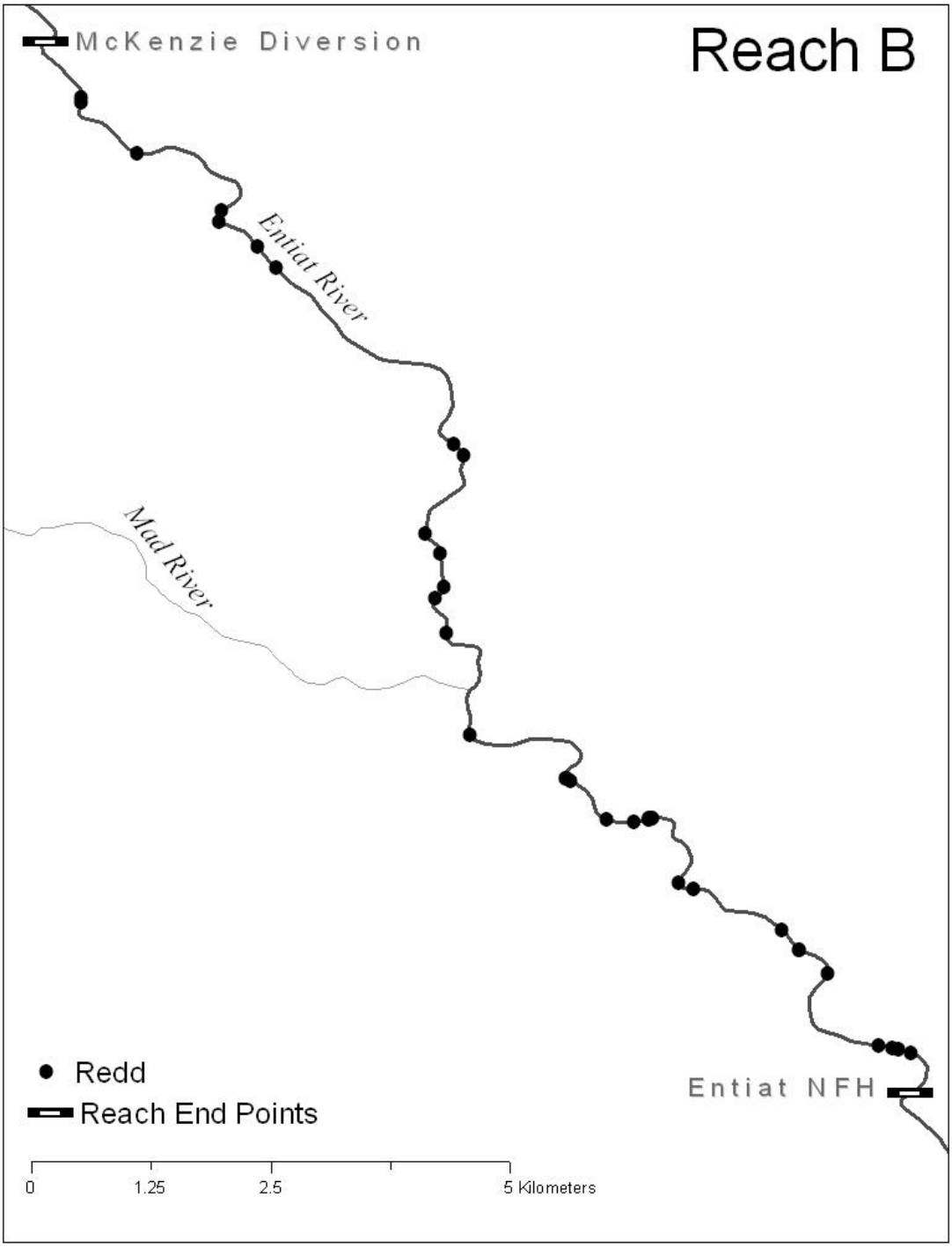

Figure 10. Steelhead redds observed on reach B (rkm 10.6 - 25.9) of the Entiat River during 2009.

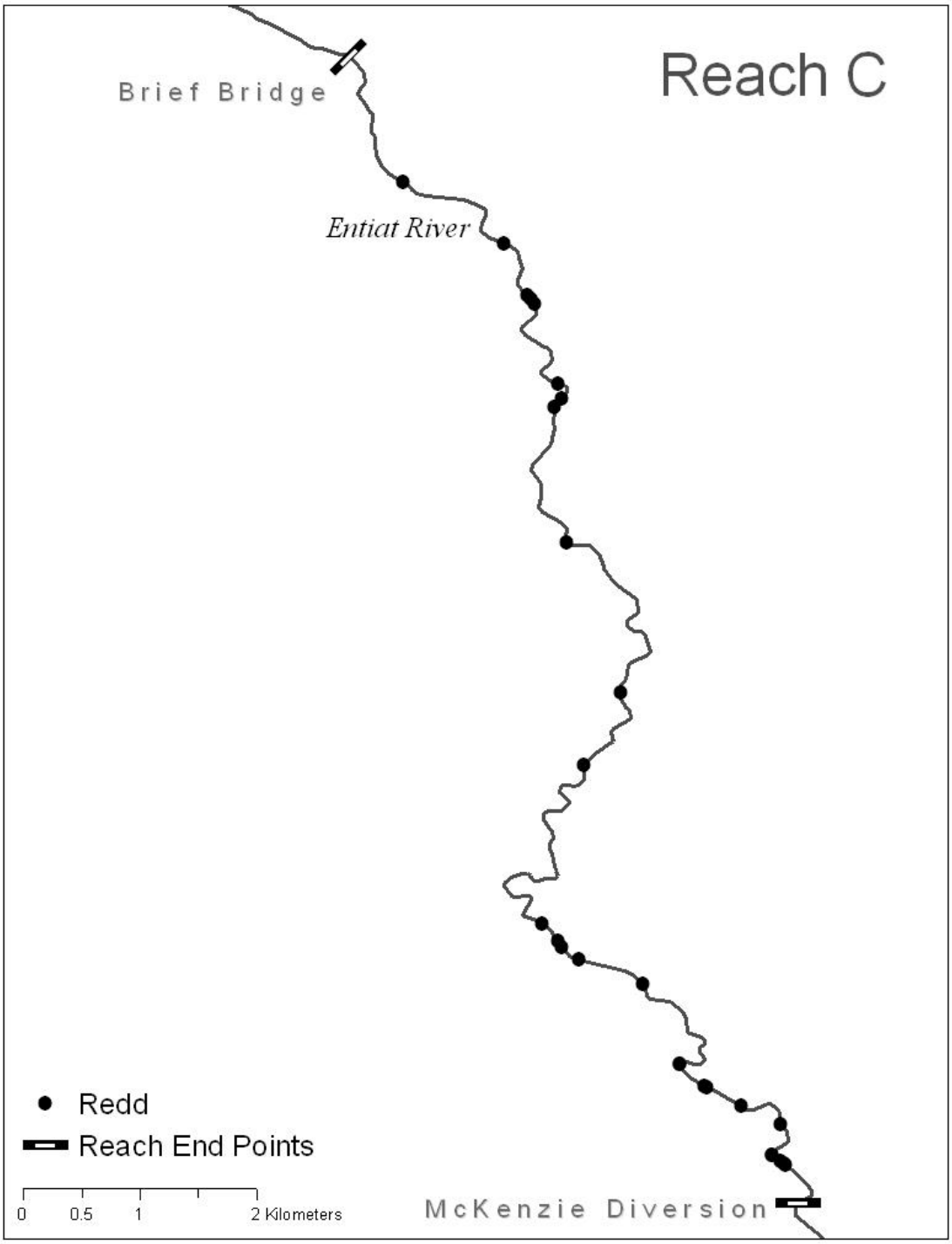

Figure 11. Steelhead redds observed on reach C (rkm 25.9 - 37.7) of the Entiat River during 2009.

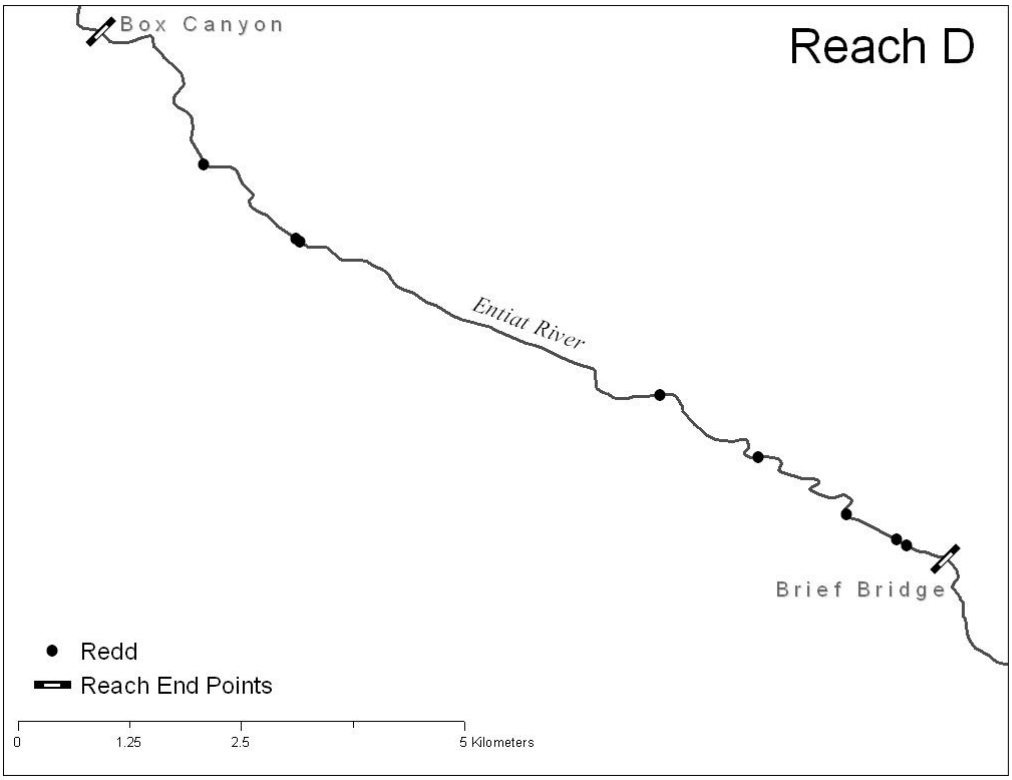

Figure 12. Steelhead redds observed on reach D (rkm 37.7 - 45) of the Entiat River during 2009.

Discussion- Steelhead Redd Surveys

In 2009 steelhead spawned in the Entiat River from late March to mid May, with the majority of new redds occurring in late April and early May. Steelhead utilized suitable spawning locations throughout the lower 45 kilometers of the river. The majority of redds were found below the ENFH at rkm 10.6. The areas of suitable gravel included restoration sites, irrigation diversions, artificial channels, and the natural river channel itself. The percentage of redds observed in the different areas has varied over the years. Steelhead redds have been found in new habitat restoration sites and irrigation diversions. Steelhead spawning use of recently disturbed sites may be result direct exposure of suitable spawning substrate, changes in water velocities that exposed gravels, collection of substrate in modified sites, or direct augmentation of substrate into site. Over the years these gravels may become embedded or overlain with larger substrate reducing their suitability for spawning. Further studies are required to fully determine the length of time these sites offer suitable spawning gravel.

Based on the first redd observed during the 2008 surveys, the 2009 surveys were began earlier than previous years (mid-February) to try and achieve zero counts on the initial surveys. Six weeks of zero redd counts from February to mid-March may be due to cool weather condition resulting in depressed early runoff events and cool water temperatures. Zero counts were achieved for each reach except reach D. For reach D, snow precluded

access to the river and in-river ice conditions prevented surveys from being safely conducted until April. The redd numbers were low in reach D compared to the other reaches and the one redd that was found during the first survey was near the downstream end of the reach. Conditions permitting, a survey in the previous week may have resulted in a zero count.

Acknowledgements

Many thanks go to the snorkelers from Mid-Columbia River Fisheries Resource Office, Leavenworth National Fish Hatchery, Yakama Nation and U.S. Forest Service. Additional thanks goes to the snorkeling support and shelter provided by Entiat National Fish Hatchery.

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Appendix

Appendix Table 1. The number of fish observed for each snorkel site and survey season during 2009, Entiat River.

Site	Species	Winter (Night)	Summer (Day)	Sub-Total
CDLT Moraine	Chinook salmon	42	155	197
	Dace spp.	0	1	1
	Mountain whitefish	1	93	94
	Rainbow/steelhead	13	41	54
	Sculpin spp.	0	7	7
	Unknown	0	302	302
Sub-Total		56	599	655
City Limits Main	Chinook salmon	1	155	156
	Dace spp.	0	1,056	1,056
	Mountain whitefish	0	118	118
	Rainbow/steelhead	51	98	149
	Red side shiner	0	1	1
	Sculpin spp.	1	4	5
	Sucker spp.	0	1	1
Sub-Total		53	1,433	1,486
City Limits Side	Chinook salmon	27	245	272
	Coho salmon	0	14	14
	Dace spp.	0	1,979	1,979
	Mountain whitefish	1	54	55
	Rainbow/steelhead	46	312	358
	Red side shiner	0	36	36
	Sculpin spp.	0	5	5
	Sucker spp.	0	194	194
	Three-spine stickleback	0	3	3
	Unknown	0	265	265
Sub-Total		74	3,107	3,181
Deskin-Wortz	Chinook salmon	55	114	169
	Dace spp.	0	1	1
	Mountain whitefish	33	63	96
	Rainbow/steelhead	19	22	41
	Sculpin spp.	4	5	9
	Sucker spp.	0	4	4
	Unknown	5	0	5
Sub-Total		116	209	325

Appendix Table 1. continued

Site	Species	Winter (Night)	Summer (Day)	Sub-Total
Dinkelman Cross Vane	Bull trout	0	1	1
	Chinook salmon	0	334	334
	Coho salmon	0	82	82
	Dace spp.	0	98	98
	Mountain whitefish	5	1,296	1,301
	Northern pikeminnow	0	1	1
	Rainbow/steelhead	58	376	434
	Sculpin spp.	0	7	7
	Sockeye salmon	0	1	1
	Sucker spp.	0	14	14
Sub-Total		63	2,210	2,273
Foreman Statues	Chinook salmon	1	97	98
	Coho salmon	0	14	14
	Dace spp.	5	13	18
	Mountain whitefish	3	234	237
	Rainbow/steelhead	67	205	272
	Sculpin spp.	2	6	8
	Sucker spp.	0	11	11
	Unknown	0	35	35
Sub-Total		78	615	693
Hanan-Detwiler Ditch[1]	Chinook salmon		195	195
	Coho salmon		92	92
	Dace spp.		10	10
	Mountain whitefish		3	3
	Rainbow/steelhead		137	137
	Sucker spp.		2	2
Sub-Total			439	439
Harrison Lower Side	Chinook salmon	18	51	69
	Coho salmon	1	48	49
	Dace spp.	0	70	70
	Mountain whitefish	2	1	3
	Rainbow/steelhead	71	26	97
	Sucker spp.	0	71	71
	Three-spine stickleback	0	85	85
Sub-Total		92	352	444

Appendix Table 1. continued

Site	Species	Winter (Night)	Summer (Day)	Sub-Total
Harrison Main	Chinook salmon	3	111	114
	Coho salmon	0	31	31
	Dace spp.	0	1,048	1,048
	Mountain whitefish	10	1,033	1,043
	Rainbow/steelhead	70	378	448
	Sculpin spp.	0	3	3
	Sucker spp.	0	2	2
	Unknown	0	285	285
Sub-Total		83	2,891	2,974
Harrison Pond	Chinook salmon	49	217	266
	Coho salmon	2	66	68
	Dace spp.	0	267	267
	Mountain whitefish	0	5	5
	Rainbow/steelhead	79	72	151
	Unknown	0	2,776	2,776
Sub-Total		130	3,403	3,533
Harrison Upper	Chinook salmon	1	144	145
	Coho salmon	0	32	32
	Dace spp.	0	3	3
	Mountain whitefish	18	789	807
	Rainbow/steelhead	20	298	318
	Sculpin spp.	0	9	9
	Sucker spp.	0	3	3
	Unknown	0	246	246
Sub-Total		39	1,524	1,563
Hatchery	Chinook salmon	1	99	100
	Chiselmouth	0	1	1
	Coho salmon	0	21	21
	Cutthroat trout	0	1	1
	Dace spp.	0	70	70
	Mountain whitefish	4	452	456
	Rainbow/steelhead	21	172	193
	Sculpin spp.	4	5	9
	Sucker spp.	0	5	5
	Unknown	0	644	644
Sub-Total		30	1,470	1,500

Appendix Table 1. continued

Site	Species	Winter (Night)	Summer (Day)	Sub-Total
Jon Small Barbs	Bull trout	0	1	1
	Chinook salmon	7	545	552
	Coho salmon	0	193	193
	Dace spp.	1	45	46
	Mountain whitefish	5	509	514
	Rainbow/steelhead	76	717	793
	Sculpin spp.	1	15	16
	Sucker spp.	0	5	5
	Unknown	0	615	615
Sub-Total		90	2,645	2,735
Keystone Canyon	Chinook salmon	9	259	268
	Chiselmouth	1	0	1
	Coho salmon	2	104	106
	Dace spp.	1	41	42
	Mountain whitefish	7	346	353
	Northern pikeminnow	0	1	1
	Rainbow/steelhead	60	421	481
	Sculpin spp.	0	5	5
	Sucker spp.	0	4	4
	Three-spine stickleback	0	10	10
	Unknown	0	126	126
Sub-Total		80	1,317	1,397
Knapp-Wham Ditch[2]	Chinook salmon		32	32
	Coho salmon		51	51
	Dace spp.		15	15
	Rainbow/steelhead		93	93
Sub-Total			191	191
Knapp-Wham Lower	Chinook salmon	0	260	260
	Coho salmon	0	228	228
	Dace spp.	2	257	259
	Mountain whitefish	2	413	415
	Rainbow/steelhead	13	531	544
	Sculpin spp.	0	14	14
	Unknown	0	500	500
Sub-Total		17	2,203	2,220

Appendix Table 1. continued

Site	Species	Winter (Night)	Summer (Day)	Sub-Total
Knapp-Wham Upper	Bull trout	0	1	1
	Chinook salmon	0	207	207
	Coho salmon	0	432	432
	Dace spp.	2	51	53
	Mountain whitefish	5	472	477
	Rainbow/steelhead	18	600	618
	Sculpin spp.	1	19	20
	Unknown	0	262	262
Sub-Total		26	2,044	2,070
Lower Stormy	Bull trout	1	0	1
	Chinook salmon	44	21	65
	Dace spp.	1	0	1
	Lamprey spp.	1	0	1
	Mountain whitefish	4	63	67
	Rainbow/steelhead	19	3	22
	Sculpin spp.	12	8	20
	Sockeye salmon	0	1	1
	Unknown	4	46	50
Sub-Total		86	142	228
Milne	Chinook salmon	5	584	589
	Coho salmon	1	235	236
	Dace spp.	0	556	556
	Lamprey spp.	1	0	1
	Mountain whitefish	29	676	705
	Rainbow/steelhead	156	747	903
	Red side shiner	0	1	1
	Sculpin spp.	0	14	14
	Sucker spp.	1	17	18
Sub-Total		193	2,830	3,023
Moen	Chinook salmon	1	7	8
	Coho salmon	0	11	11
	Dace spp.	0	282	282
	Rainbow/steelhead	1	2	3
	Sucker spp.	0	1	1
	Unknown	0	30	30
Sub-Total		2	333	335

Appendix Table 1. continued

Site	Species	Winter (Night)	Summer (Day)	Sub-Total
Powerline	Chinook salmon	0	13	13
	Dace spp.	0	147	147
	Mountain whitefish	0	255	255
	Rainbow/steelhead	34	74	108
	Sculpin spp.	0	4	4
Sub-Total		34	493	527
PUD Side	Chinook salmon	20	1,703	1,723
	Chiselmouth	0	1	1
	Coho salmon	0	189	189
	Dace spp.	2	0	2
	Lamprey spp.	1	0	1
	Mountain whitefish	0	391	391
	Rainbow/steelhead	119	485	604
	Three-spine stickleback	1	0	1
Sub-Total		143	2,769	2,912
Sego-Yurt	Bull trout	3	0	3
	Chinook salmon	18	57	75
	Cutthroat trout	0	1	1
	Mountain whitefish	0	49	49
	Rainbow/steelhead	24	13	37
	Sculpin spp.	9	8	17
Sub-Total		54	128	182
Split Channel North	Chinook salmon	2	34	36
	Coho salmon	0	9	9
	Dace spp.	10	6	16
	Mountain whitefish	1	81	82
	Rainbow/steelhead	18	105	123
	Sculpin spp.	0	6	6
	Sucker spp.	1	0	1
	Unknown	0	1,172	1,172
Sub-Total		32	1,413	1,445

Appendix Table 1. continued

Site	Species	Winter (Night)	Summer (Day)	Sub-Total
Split Channel South	Coho salmon	0	7	7
	Dace spp.	0	102	102
	Mountain whitefish	0	83	83
	Rainbow/steelhead	48	233	281
	Sculpin spp.	1	32	33
	Sucker spp.	0	5	5
	Unknown	0	864	864
Sub-Total		54	1,560	1,614
Stanton-Love	Bull trout	0	4	4
	Chinook salmon	2	512	514
	Coho salmon	0	453	453
	Dace spp.	0	54	54
	Mountain whitefish	13	501	514
	Northern pikeminnow	0	2	2
	Rainbow/steelhead	65	799	864
	Sculpin spp.	1	26	27
	Sucker spp.	0	25	25
	Unknown	0	456	456
Sub-Total		81	2,832	2,913
Upper Stormy	Bull trout	1	0	1
	Chinook salmon	63	181	244
	Mountain whitefish	2	13	15
	Rainbow/steelhead	18	30	48
	Sculpin spp.	2	6	8
	Unknown	3	0	3
Sub-Total		89	230	319
Whitehall Cross Vane	Chinook salmon	1	629	630
	Coho salmon	0	140	140
	Dace spp.	0	19	19
	Mountain whitefish	14	825	839
	Rainbow/steelhead	106	365	471
	Red side shiner	0	18	18
	Sculpin spp.	2	6	8
	Sockeye salmon	0	1	1
	Unknown	0	73	73
Sub-Total		123	2,076	2,199

Appendix Table 1. continued

Site	Species	Winter (Night)	Summer (Day)	Sub-Total
Wilson Main	Chinook salmon	0	335	335
	Coho salmon	0	66	66
	Dace spp.	0	495	495
	Mountain whitefish	9	476	485
	Rainbow/steelhead	22	165	187
	Sculpin spp.	2	6	8
	Sucker spp.	0	9	9
	Unknown	0	1,449	1,449
Sub-Total		33	3,001	3,034
Wilson Side Channel	Chinook salmon	49	423	472
	Coho salmon	0	175	175
	Dace spp.	0	782	782
	Mountain whitefish	10	1,339	1,349
	Rainbow/steelhead	30	185	215
	Red side shiner	0	1	1
	Sucker spp.	18	786	804
	Unknown	1	73	74
Sub-Total		108	3,764	3,872
Grand Total		2,059	48,223	50,282

[1] ditch was closed and contained no water so it was therefore not surveyed

[2] ditch was closed due to construction and was therefore not surveyed

Appendix Table 2. Detailed Rotary Screw Trap capture summary for the Entiat River, 2009.

Species and Life Stage	Total Capture	Capture Mortality
Spring Chinook (unknown r/t) adult	1	0
Wild spring Chinook salmon adult	4	0
Wild spring Chinook salmon juvenile	11,578	201
Hatchery summer Chinook salmon adult	2	0
Hatchery summer Chinook salmon jack	1	0
Wild summer Chinook salmon adult	1	0
Wild summer Chinook salmon juvenile	15,765	103
Wild Chinook (unknown run) salmon adult	1	0
Wild Chinook (unknown run) salmon precocial	81	0
Wild Chinook (unknown run) salmon juvenile	8	0
Hatchery coho salmon adult	1	0
Hatchery coho salmon juvenile	1	0
Wild coho salmon adult	4	0
Wild coho salmon juvenile	97	0
Hatchery summer steelhead adult	1	0
Summer steelhead (unknown r/t) adult	1	0
Wild summer steelhead adult	2	0
Wild steelhead juvenile	2,968	49
Wild rainbow trout juvenile	1	0
Bull trout adult	8	0
Bull trout juvenile	98	0
Wild cutthroat trout adult	1	0
Wild cutthroat trout juvenile	20	0
Wild sockeye (unknown run) salmon juvenile	642	8
Pacific lamprey adult	1	0
Pacific lamprey ammocoete	2,781	2
Pacific lamprey transformer	5	0
Northern pikeminnow adult	9	0
Northern pikeminnow juvenile	48	1
Mountain whitefish adult	28	0
Mountain whitefish juvenile	2,135	53
Unknown sucker adult	29	0
Unknown sucker juvenile	296	1
Unknown dace adult	1	0
Unknown dace juvenile	1,436	23
Chiselmouth adult	4	0
Chiselmouth juvenile	23	0
Unknown sculpin	84	9
Red side shiner	157	0
Three-spine stickleback	25	1
Other (unknown species)	2	0
Total	**38,351**	**451**

Appendix Table 3. Detailed remote capture summary for the Entiat and Mad rivers, 2009.

Species and Life Stage	Total Capture	Capture Mortality
Wild Chinook (unknown run) salmon juvenile	952	30
Wild coho salmon juvenile	13	0
Wild steelhead juvenile	1,232	8
Bull trout juvenile	12	0
Brook trout	18	0
Wild cutthroat trout juvenile	7	0
Pacific lamprey ammocoete	3	0
Mountain whitefish juvenile	119	9
Unknown dace juvenile	233	0
Unknown sculpin	171	0
Total	**2,760**	**47**